# Appendix A: Example Calculations of Statistical Methods

## 1.0 Example 1

Assume 12 baseline iron loading observations are collected by sampling once per month for a year. Likewise, 12 iron loading monitoring observations are obtained by sampling once per month for a period of one year. In order to determine whether baseline pollution loading has been exceeded, both Procedures A and B were used. For all calculations in Example 1, assume the following iron loading observations (lbs/day).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | 1.33 | 0.53 | 0.92 | 0.82 | 0.88 | 0.79 | 0.87 | 0.73 | 0.83 | 0.89 | 1.10 | 0.86 |
| Monitoring | 0.94 | 0.74 | 0.87 | 1.03 | 0.91 | 1.00 | 0.80 | 1.19 | 1.16 | 1.15 | 1.12 | 0.91 |

## <u>1.1</u> <u>Procedure A</u> (Figure 3.2a)

### 1.1.1 Single Observation Trigger:

1) Twelve baseline observations were collected, therefore n = 12.

2) The baseline observations were placed in sequencial order from smallest to largest.
[0.53, 0.73, 0.79, 0.82, 0.83, 0.86, 0.87, 0.88, 0.89, 0.92, 1.10, 1.33]

3) The number of observations, n, is less then 16, therefore the Single Observation Trigger (L) equals $x_{(12),}$ (the maximum) = 1.33.

4) All monitoring observations are less than 1.33, therefore the Single Observation Trigger (L) (1.33) was not exceeded.

### 1.1.2 Subtle Trigger

1) Twelve is an even number, therefore the median of the baseline observations is:
$M = 0.5 * (x_{(6)} + x_{(7)})$.
$M = 0.5 * (0.86 + 0.87) = 0.865$

In order to determine $M_1$, calculate the median of the subset ranging from $x_{(7)}$ to $x_{(12)}$.
Because 12 - 6 = 6 is even, $M_1 = 0.5 * (x_{(9)} + x_{(10)})$
$M_1 = 0.5 * (0.89 + 0.92) = 0.905$

2) In order to determine $M_{-1}$, calculate the median of the subset ranging from $x_{(1)}$ to $x_{(6)}$.
Because 6 is even, $M_{-1} = 0.5 * (x_{(3)} + x_{(4)})$
$M_{-1} = 0.5 * (0.79 + 0.82) = 0.805$

3) To calculate R, subtract $M_{-1}$ from $M_1$.
$R = 0.905-0.805 = 0.1$

4) The calculated value for R, is then substituted into the equation for T.

$$T = 0.865 + \frac{1.58 * [(1.25 * 0.1)]}{(1.35 * \sqrt{12})} = 0.907$$

5) The following monitoring observations are ordered from smallest to largest.
[0.74, 0.80, 0.87, 0.91, 0.91, 0.94, 1.00, 1.03, 1.12, 1.15, 1.16, 1.19]

6) There are 12 monitoring observations, therefore m = 12.
The number of observations is even, therefore $M' = 0.5 * (x_{(6)} + x_{(7)})$
$M' = 0.5 * (0.94 + 1.00) = 0.97$
This holds true for $M_1'$ and $M_{-1}'$ as well.
$M_1' = 0.5 * (x_{(9)} + x_{(10)}) = 0.5 * (1.12 + 1.15) = 1.135$
$M_{-1}' = 0.5 * (x_{(3)} + x_{(4)}) = 0.5 * (0.87 + 0.91) = 0.89$

7) To calculate R, subtract $M_{-1}'$ from $M_1'$.
$R' = 1.135 - 0.89 = 0.245$.

8) The calculated value for R' is then substituted in the equation for T'.

$$T' = 0.925 - \frac{1.58 * [(1.25 * 0.245)]}{(1.35 * \sqrt{12})} = 0.867$$

9) T' (0.867) is less than T (0.907), therefore the median baseline pollution loading was not exceeded.

## <u>1.2</u> <u>Procedure B</u> (Figure 3.2b)

### 1.2.1 Calculation of Single Observation Limit

1) Again, the number of baseline observations, n = 12.

2) The following log-transformed (using natural logs) baseline observations are sequencially ordered from smallest to largest. [-0.64, -0.31, -0.24, -0.20, -0.19, -0.15, -0.14, -0.13, -0.12, -0.08, 0.10, 0.29]

3) The mean of the 12 log-transformed observations, $E_y$ = -0.15.

4) An appropriate estimate of the first-order autocorrelation ($\rho_1$ ^) of the log-transformed data is 0.5. Given the number of observations and the auto-correlation estimate, the following equation is used to calculate A.

$$A = \frac{1}{[1-(\frac{2}{12})*0.5]} = 1.09$$

5) The factor A is then used to calculate $S^2_y$.

$$S_y^2 = 1.09 * \sum \frac{[y_i-(-0.15)]^2}{n-1} = 0.0535$$

6) To find $E_x$ the values for $E_y$ and $S_y^2$ into the following equation:
$E_x = \exp[(E_y) + (0.5 * S_y^2)]$
$E_x = \exp[(-0.15) + (0.5 * 0.0535)] = \exp(-0.12325) = 0.884$

7) The Single Observation Limit ($L_{so}$) is defined as the following:
$L_{so} = \exp[(E_y) + (Z_{99} * \sqrt{S_y^2})]$
$L_{so} = \exp[(-0.15) + (2.3263 * \sqrt{0.0535})]$
$L_{so} = \exp[0.388] = 1.47$

8) Monitoring observations are below 1.47, therefore the $L_{so}$ was not exceeded.

### 1.2.2 Calculation of Single Observation Warning Level

1) The Single Observation Warning Level ($WL_{so}$) is determined by using the following equation:

$$WL_{so} = \exp\ [(-0.15)\ +\ (1.6449 * \sqrt{0.0535})]\ =\ \exp[0.230]\ =\ 1.26$$

2) All of the monitoring observations are below 1.26, therefore the Single Observation Warning Level was not exceeded.

### 1.2.3 Calculation of Cusum test

1) The number of monitoring observations, n = 12.

2) The log-transformed (using natural logs) monitoring observations are listed and labeled sequencially, in order of collection.

| | $Y_1$ | $Y_2$ | $Y_3$ | $Y_4$ | $Y_5$ | $Y_6$ | $Y_7$ | $Y_8$ | $Y_9$ | $Y_{10}$ | $Y_{11}$ | $Y_{12}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Obs. | -0.06 | -0.30 | -0.14 | 0.03 | -0.09 | 0.00 | -0.22 | 0.17 | 0.15 | 0.14 | 0.11 | -0.09 |

3) Using the values for $E_y$ and $S_y^2$ from the $L_{so}$ calculations, the value for K can be determined using the following equation:

$$K = [(E_y\ ) + 0.25(\sqrt{S_y^2}\ )]$$
$$K = (-0.15) + 0.25 * (0.229) = - 0.092$$

4) The values for $C_{(t)}$, can be determined using the following equation:

$$C_t = C_{t-1} + (Y_n - K) \text{ for example}$$
$$C_1 = 0 + (-0.06 - (-0.093)) = 0.033$$

The values for $C_t$ are given in the following table for each collection time t. Negative $C_t$ values are replaced with 0, as shown in parentheses.

| **t** | **$C_t$** | **t** | **$C_t$** |
|---|---|---|---|
| 1 | 0.033 | 7 | 0.092 |
| 2 | -0.174 (0) | 8 | 0.355 |
| 3 | -0.047 (0) | 9 | 0.598 |
| 4 | 0.123 | 10 | 0.831 |
| 5 | 0.126 | 11 | 1.034 |
| 6 | 0.219 | 12 | 1.037 |

5) The baseline pollution Cusum Single Observation Limit, H, can be determined using the following equation:
$H = 8.0 * (\sqrt{S_y^2})$
$H = 8.0 * 0.229 = 1.850$

6) All values for C are below 1.850, therefore the baseline pollution Cusum Single Observation Limit was not exceeded.

### 1.2.4 Cusum Warning Level

1) The number of monitoring observations, n = 12.

2) The following equation can be used to determine $K_w$:
$K_w = [(E_y) + 0.5(\sqrt{S_y^2})]$
$K_w = [(-0.15) + 0.5(0.229)] = -0.0393$

3) The values for $W_t$, can be determined using the following equation:
$W_t = W_{t-1} + (Y_n - (K_w))$ for example
$W_1 = 0 + (-0.06 - (-0.0355)) = -0.0245 = 0.00$

The limit values, $W_t$, are given in the following table for each collection time t. Negative $W_t$ values were replaced with 0, as shown in parentheses.

| t | $W_t$ | t | $W_t$ |
|---|---|---|---|
| 1 | -0.0257 (0) | 7 | -0.1428 (0) |
| 2 | -0.2657 (0) | 8 | 0.2043 |
| 3 | -0.1057 (0) | 9 | 0.3886 |
| 4 | 0.0643 | 10 | 0.5629 |
| 5 | 0.0086 | 11 | 0.7072 |
| 6 | 0.0429 | 12 | 0.6515 |

5) The baseline pollution Cusum Warning Level, $H_w$, can be determined using the following equation:

$$H_w = 3.5 *(\sqrt{S_y^2})$$
$$H_w = 3.5 * (0.229) = 0.8096$$

6) All values for $W_t$ are below 0.8096, therefore the baseline pollution Cusum Warning Level was not reached or exceeded.

## 1.3 Annual Comparisons

### 1.3.1 Wilcoxon-Mann-Whitney Test

Instructions for the Wilcoxon-Mann-Whitney test are given in Conover (1980), cited in Figure 3.2b.

1) When using both baseline and monitoring data, n = 12 and m =12

2) The baseline and monitoring observations are listed with their corresponding rankings.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline Observations | 0.53 | 0.73 | 0.79 | 0.82 | 0.83 | 0.86 | 0.87 | 0.88 | 0.89 | 0.92 | 1.10 | 1.33 |
| Baseline Rankings | 1 | 2 | 4 | 6 | 7 | 8 | *9.5* | 11 | 12 | 15 | 19 | 24 |

| Monitoring Observations | 0.74 | 0.80 | 0.87 | 0.91 | 0.91 | 0.94 | 1.00 | 1.03 | 1.12 | 1.15 | 1.16 | 1.19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monitoring Rankings | 3 | 5 | *9.5* | *13.5* | *13.5* | 16 | 17 | 18 | 20 | 21 | 22 | 23 |

Due to the fact that values of 0.87 and 0.91 were each obtained for more than one observation. The average rankings are obtained for these values. For 0.87, the average of 9 and 10 is 9.5. For 0.91, the average of 13 and 14 is 13.5.

3) The sum of the twelve baseline ranks, $S_n$ = 118.5.

4) In order to find the appropriate critical value (C), match the column with the correct n (number of baseline observations) to the row with the correct m (number of monitoring observations). As found in the table, the critical value C for 12 baseline and 12 monitoring observations is 121.

*Critical Values (C) of the Wilcoxon-Mann-Whitney Test*
*(for a one-sided test at the 95 percent level)*

| n<br>m | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 83 | 98 | 113 | 129 | 147 | 165 | 185 | 205 | 227 | 249 | 273 |
| 11 | 87 | 101 | 117 | 134 | 152 | 171 | 191 | 211 | 233 | 256 | 280 |
| 12 | 90 | 105 | 121 | 139 | 157 | 176 | 197 | 218 | 240 | 263 | 288 |
| 13 | 93 | 109 | 126 | 143 | 162 | 182 | 202 | 224 | 247 | 271 | 295 |
| 14 | 97 | 113 | 130 | 148 | 167 | 187 | 208 | 231 | 254 | 278 | 303 |
| 15 | 100 | 117 | 134 | 153 | 172 | 193 | 214 | 237 | 260 | 285 | 311 |
| 16 | 104 | 121 | 139 | 157 | 177 | 198 | 220 | 243 | 267 | 292 | 318 |
| 17 | 107 | 124 | 143 | 162 | 183 | 204 | 226 | 250 | 274 | 300 | 326 |
| 18 | 111 | 128 | 147 | 167 | 188 | 209 | 232 | 256 | 281 | 307 | 334 |
| 19 | 114 | 132 | 151 | 172 | 193 | 215 | 238 | 263 | 288 | 314 | 341 |
| 20 | 118 | 136 | 156 | 176 | 198 | 221 | 244 | 269 | 295 | 321 | 349 |

5) $S_n$ (118.5) is less than C (121). Therefore, according to the Wilcoxon-Mann-Whitney test, the monitoring observations did exceed the baseline pollution loading.

## 2.0 Example 2

Assume 18 baseline iron loading determination observations are collected by sampling twice per month for nine months. Likewise, 18 iron loading monitoring observations are obtained by sampling twice per month for a period of nine months. In order to determine whether baseline pollution loading has been exceeded, examples of Procedures A and B are presented below. For all calculations in Example 2, assume the following iron loading observations (in lbs/day):

| Observation | Baseline | Monitoring |
|---|---|---|
| 1 | 0.030 | 0.530 |
| 2 | 0.005 | 0.040 |
| 3 | 1.915 | 1.040 |
| 4 | 0.673 | 0.033 |
| 5 | 0.064 | 0.030 |
| 6 | 0.063 | 0.230 |
| 7 | 0.607 | 0.710 |
| 8 | 0.553 | 0.240 |
| 9 | 0.286 | 0.390 |
| 10 | 0.106 | 0.830 |
| 11 | 0.406 | 3.050 |
| 12 | 1.447 | 0.580 |
| 13 | 0.900 | 1.180 |
| 14 | 0.040 | 0.510 |
| 15 | 2.770 | 0.046 |
| 16 | 1.803 | 0.690 |
| 17 | 0.160 | 0.630 |
| 18 | 0.045 | 0.370 |

## <u>2.1 Procedure A</u>

### 2.1.1 Single Observation Trigger

1) The number of baseline observations collected, $n = 18$.

2) The baseline observations are ordered sequencially from smallest to largest.
[0.005, 0.030, 0.040, 0.045, 0.063, 0.064, 0.106, 0.160, 0.286, 0.406, 0.553, 0.607, 0.673, 0.900, 1.447, 1.803, 1.915, 2.770]

3) The number of observations is greater than 16, therefore M, $M_1$, $M_2$ and $M_3$ must be calculated. The number of observations is even, which means the median of the baseline observations must be calculated using the following equation:
$M = 0.5 * (x_{(9)} + x_{(10)})$.
$M = 0.5 * (0.286 + 0.406) = 0.346$

4) To determine $M_1$, calculate the median of the subset ranging from $x_{(10)}$ to $x_{(18)}$.
$18 - 9 = 9$ is odd, therefore $M_1 = x_{(14)} = 0.900$.

5) To determine $M_2$, calculate the median of the subset ranging from $x_{(14)}$ to $x_{(18)}$.
$18 - 13 = 5$ is odd, therefore $M_2 = x_{(16)} = 1.803$.

6) To determine $M_3$, calculate the median of the subset ranging from $x_{(16)}$ to $x_{(18)}$.
$18 - 15 = 3$, which is odd, therefore $M_3 = x_{(17)} = 1.915$.

7) To determine L, calculate the median of the subset ranging from $x_{(17)}$ to $x_{(18)}$.
$18 - 16 = 2$, which is even, therefore $L = 0.5 * (x_{(17)} + x_{(18)}) = 0.5 * (1.915 + 2.770) = 2.343$.

8) One monitoring observation, 3.050, is above L, (2.343), therefore the Single Observation Trigger was exceeded.

### 2.1.2 Subtle Trigger:

1) As determined in section 2.1.1, $M = 0.346$, and $M_1 = 0.900$.

2) To find $M_{-1}$, calculate the median of the subset ranging from $x_{(1)}$ to $x_{(9)}$.
9 is odd, therefore $M_{-1} = x_{(5)} = 0.063$.

3) The value for R is found by subtracting $M_{-1}$ from M
$R = 0.900-0.063 = 0.837$

4) To find T, the value for R is inserted in the following equation:

$$T = 0.346 + \frac{1.58 * [(1.25 * 0.837)]}{(1.35 * \sqrt{18})} = 0.635$$

5) The monitoring observations are placed in order from lowest to highest.

[0.030, 0.033, 0.040, 0.046, 0.230, 0.240, 0.370, 0.390, 0.510, 0.530, 0.580, 0.630, 0.690, 0.710, 0.830, 1.040, 1.180, 3.050]

6) The number of monitoring observations, m = 18.

18 is even, making M' = 0.5 * ($x_{(9)}$ + $x_{(10)}$)

M' = 0.5 * (0.510 + 0.530) = 0.520

7) To determine $M_1'$, calculate the median of subset $x_{(10)}$ to $x_{(18)}$.

Because 18 - 9 = 9 is odd, $M_1'$ = ($x_{(14)}$) = 0.710

8) To determine $M_{-1}'$, calculate the median of subset $x_{(1)}$ to $x_{(9)}$.

Because 9 is odd, $M_{-1}'$ = ($x_{(5)}$) = 0.230

9) The value for R' is found by subtracting $M_{-1}'$ from $M_1'$.

R' = 0.710 - 0.230 = 0.48

10) To find T', the value for R' is inserted into the following equation:

$$T' = 0.520 - \frac{1.58 * [(1.25 * 0.48)]}{(1.35 * \sqrt{18})} = 0.354$$

11) T' (0.354) is less than T (0.635), therefore the median baseline pollution loading is not exceeded.

## 2.2 Procedure B

### 2.2.1 Calculation of Single Observation Limit

1) The number of baseline observations, n = 18.

2) The natural log-transformed baseline observations are place in order from smallest to largest.
[-5.30, -3.51, -3.22, -3.10, -2.76, -2.75, -2.24, -1.83, -1.25, -0.90, -0.59, -0.50, -0.40, -0.11, 0.37, 0.59, 0.65, 1.02]

3) The mean of the 18 log-transformed observations, $E_y$, is -1.44.

4) Given the number of observations, the following equation is used to find A.

$$A = \frac{1}{1-(\frac{2}{18}*0.5)} = 1.06$$

5) The factor A is then used to calculate $S_y^2$.

$$S_y^2 = 1.06 * \sum \frac{[(y_i-(-1.44))^2]}{17} = 3.24$$

6) To find $E_x$, the following equation is used:
$E_x = \exp[(E_y) + (0.5\,(S_y^2))]$
$E_x = \exp[(-1.44) + (0.5 * 3.24)] = \exp[0.18] = 1.20$

7) Using the values that have been calculated the Single Observation Limit is found.

$$L_{so} = \exp\ [(-1.44) + (2.3263*\sqrt{3.24})] = \exp[2.75] = 15.60$$

8) All of the monitoring observations are below 15.60, therefore the Single Observation Limit was not exceeded.

### 2.2.2 Warning Level

1) The Single Observation Warning Limit ($WL_{so}$) is determined using the following equation:

$$WL_{so} = \exp\ [(-1.44)\ +\ (1.6449 * \sqrt{3.24})]\ =\ \exp[1.52]\ =\ 4.58$$

2) All of the monitoring observations are below 4.58, therefore the Single Observation Warning Level is not exceeded.

### 2.2.3 Calculation of Cusum limit

1) The number of monitoring observations, n = 18.

2) The log-transformed monitoring observations are listed and labeled, in order of collection.

| **Natural Log-Transformed Monitoring Observations** | | **Natural Log-Transformed Monitoring Observations** | |
|---|---|---|---|
| $Y_1$ | -0.63 | $Y_{(10)}$ | -0.19 |
| $Y_2$ | -3.22 | $Y_{(11)}$ | 1.12 |
| $Y_3$ | 0.04 | $Y_{(12)}$ | -0.54 |
| $Y_4$ | -3.41 | $Y_{(13)}$ | 0.17 |
| $Y_5$ | -3.51 | $Y_{(14)}$ | -0.67 |
| $Y_6$ | -1.47 | $Y_{(15)}$ | -3.08 |
| $Y_7$ | -0.34 | $Y_{(16)}$ | -0.37 |
| $Y_8$ | -1.43 | $Y_{(17)}$ | -0.46 |
| $Y_9$ | -0.94 | $Y_{(18)}$ | -0.99 |

3) Using the values for $E_y$ and $S_y^2$ from the $L_{so}$ calculations, the value for K can be determined using the following equation:

$K = [(E_y) + 0.25(\sqrt{S_y^2})]$

$K = (-1.44) + 0.25 * 1.8 = -0.99$

4) The values for $C_t$, can be determined using the following equation:

$C_t = C_{t-1} + (Y_n - K)$ for example

$C_1 = -0.63 - (-0.99) = 0.36$

The values for $C_t$ are given in the table for each collection time t. Negative $C_t$ values are replaced with 0, as shown in parentheses.

| t | $C_t$ | t | $C_t$ |
|---|---|---|---|
| 1 | 0.36 | 10 | 1.06 |
| 2 | -1.87 (0) | 11 | 3.17 |
| 3 | 1.03 | 12 | 3.62 |
| 4 | -1.39 (0) | 13 | 4.78 |
| 5 | -2.52 (0) | 14 | 5.10 |
| 6 | -0.48 (0) | 15 | 3.01 |
| 7 | 0.65 | 16 | 3.63 |
| 8 | 0.21 | 17 | 4.16 |
| 9 | 0.26 | 18 | 4.16 |

5) The baseline pollution Cusum Single Observation Limit, H, can be determined using the following equation:

$H = 8.0 * (\sqrt{S_y^2})$

$H = 8.0 * (1.8) = 14.4$

6) All values for $C_t$ are below 14.4, therefore the baseline pollution Cusum Single Observation Limit was not exceeded.

### 2.2.4 Cusum Warning Level

1) The number of monitoring observations, n = 18.

2) The following equation can be used to determine $K_w$:

$K_w = [(E_y) + 0.5(\sqrt{S_y^2})]$

$K_w = [(-1.44) + 0.5(1.8)] = -0.54$

3) The values for $W_t$, can be determined using the following equation:

$W_t = W_{t-1} + (Y_n - K_w)$ for example

$W_1 = 0 + (-0.06 - (-0.0355)) = -0.0245$ (0)

The limit values, $W_t$, are given in the table for each collection time t. Negative $W_t$ values were replaced with 0, as shown in parentheses, and in the equation above.

| **t** | **$W_t$** | **t** | **$W_t$** |
|---|---|---|---|
| 1 | -0.09 (0) | 10 | 0.35 |
| 2 | -2.68 (0) | 11 | 2.01 |
| 3 | 0.58 | 12 | 2.01 |
| 4 | -2.29 (0) | 13 | 2.72 |
| 5 | -2.97 (0) | 14 | 2.59 |
| 6 | -0.93 (0) | 15 | 0.05 |
| 7 | 0.20 | 16 | 0.22 |
| 8 | -0.69 (0) | 17 | 0.30 |
| 9 | -0.40 (0) | 18 | -0.15 (0) |

4) The baseline pollution Cusum Warning Level, $H_w$, can be determined using the following equation:

$$H_w = 3.5 *(\sqrt{S_y^2})$$
$$H_w = 3.5 * (1.8) = 6.3$$

5) All values for $W_t$ are below 6.3, therefore the baseline pollution Cusum Warning Level was not exceeded.

## 2.3 Annual Comparisons

### 2.3.1 Wilcoxon-Mann-Whitney test

Instructions for the Wilcoxon-Mann-Whitney test are given in Conover (1980), cited in Figure 3.2b.

1) When using both baseline and monitoring data, n = 18 and m = 18.

2) The baseline and monitoring observations are listed in order of collection, and ranked as follows:

| **Baseline Observations** | | **Monitoring Observations** | |
|---|---|---|---|
| 0.030 | 2.5 | 0.530 | 20 |
| 0.005 | 1 | 0.040 | 6 |
| 1.915 | 34 | 1.040 | 30 |
| 0.673 | 25 | 0.033 | 4 |
| 0.064 | 10 | 0.030 | 2.5 |
| 0.063 | 9 | 0.230 | 13 |
| 0.607 | 23 | 0.710 | 27 |
| 0.553 | 21 | 0.240 | 14 |
| 0.286 | 15 | 0.390 | 17 |
| 0.106 | 11 | 0.830 | 28 |
| 0.406 | 18 | 3.050 | 36 |
| 1.447 | 32 | 0.580 | 22 |
| 0.900 | 29 | 1.180 | 31 |
| 0.040 | 5 | 0.510 | 19 |
| 2.770 | 35 | 0.046 | 8 |
| 1.803 | 33 | 0.690 | 26 |
| 0.160 | 12 | 0.630 | 24 |
| 0.045 | 7 | 0.370 | 16 |

The value of 0.030 was obtained for more than one observation. The ranking displayed is the average of 2 and 3 (2.5).

3) The sum of the 18 baseline ranks, $S_n$ = 322.5.

4) From the table in section 1.3.1 of this appendix, the critical value (C) for 18 baseline and 18 monitoring observations is 281.

5) $S_n$ (322.5) is greater than the critical value for C (281).  Therefore, according to the Wilcoxon-Mann-Whitney test, the monitoring observations did not exceed the baseline pollution loading.